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REMEDIATION (CLEAN-UP) OF CONTAMINATED UNCONTROLLED SUPERFUND DUMPSITES BY INCINERATION AND OTHER POPULAR TECHNOLOGIES

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ABSTRACT

The Risk Reduction Engineering Laboratory (RREL) has been active in the past year or more in its new Superfund Technical Assistance Response Team (START) program. The function of the START program is to provide technical assistance to all of EPA's ten (10) Regional Office program managers who are responsible for selecting and implementing the optimum remediation technologies for clean-up of individual Superfund sites across the U.S. Among the technologies involved are: incineration, chemical treatment, physical treatments including barriers with pumping and treating liquid pollutants, and solidification. RREL START activities also involve the conduct of bench- or pilot-scale treatability tests of specific soil and pollutant characteristics.

This paper describes the typical nature of a number of example Superfund sites and the overall experience in effective remediation of such problems to date. In addition, six specific case studies are described which exemplify the successful use of incineration (four sites), chemical treatment (one site), and solidification (one site). It is the authors' hope that other countries may benefit from EPA's and Focus' growing experience and knowledge in these clean-up activities.

INTRODUCTION

USEPA's Risk Reduction Engineering Laboratory (RREL) has been active over the past several years providing technical assistance on the U.S. Government's behalf to EPA program managers in EPA's ten (10) Regional Offices and other governmental agencies on the clean-up of uncontrolled dumpsites. In particular, the EPA authors as members of RREL's new

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Superfund Technical Assistance Response Team (START) program have contributed to studies, technical assistance, and procurement actions for contaminated soil and waste site treatment actions via incineration (2, 3, 4, 7).

Similarly, but from the industrial perspective, Focus Environmental Incorporated has been active in maintaining up-to-date information on the various designs, keeping lists of the manufacturing suppliers, and the owner/operators of the many mobile/transportable incinerators which have been used in full-scale clean-up actions (1). Focus has provided expert assistance to government and industrial sectors in the selection of specific mobile/transportable incinerator(s) which best serve specific case-by-case needs.

Although this paper emphasizes thermal destruction or incineration, other technologies are also being effectively used in Superfund site clean-up. Among these are chemical treatment, physical treatments such as soils washing, vapor extraction, physical barriers such as capping and grouting used with pumping and treating liquid pollutants, and solidification/stabilization. Beyond what might be termed the "traditional" incineration technologies which are more or less in widespread use, there are also a number of newer concepts of an innovative or developing nature that EPA or others are studying. Examples of these are in-situ vitrification (ISV) where electrodes are used to melt volumes of soil in place, an electric arc plasma process which melts excavated materials, and radio frequency heating to remove contaminants.

This paper describes the nature of a number of typical Superfund sites where incineration is applicable and also summarizes the overall experience in effective remediation of such problems to date. In addition, case studies for the successful use of incineration are described (four sites), chemical treatment (one site), and solidification (one site). It is the authors' hope that other countries who are members of the Pacific Basin Consortium for Hazardous Waste Research may benefit from EPA's and Focus's growing experience and knowledge in these clean-up or remediation activities.

REGULATORY BACKGROUND

Clean-up of uncontrolled U.S. waste sites created by poor disposal practices of the past is regulated by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 [CERCLA - Public Law (PL) 96-510] and the Superfund Amendments and Reauthorization Act of 1986 (SARA - PL 99-499). A national fund (Superfund) was created to assist in remedial actions on these sites. CERCLA/SARA establishes a contingency plan to clarify the responsibilities and to determine the procedures and standards for responding to releases of hazardous substances including priorities for remedial action - taking into account the potential urgency of such action. This prioritization becomes the National Priorities List (NPL) - a listing which defines a site as a Superfund site. There are more than 1200 Final and Proposed Superfund Sites on the National Priorities List as of February 1990. When a waste site is determined to pose an imminent and substantial endangerment to the public health or welfare or the environment because of an actual or threatened release of a hazardous substance, it is designated a Superfund site when a Removal Action is placed against it. Of the 1200 NPL Superfund sites, approximately 93 have "Records of Decision" (RODs) on file which indicate the selection of one or more types of off-site or on-site thermal treatment as the remedial action of choice for portions of the site, or in some cases, the entire site. Of these 93 Superfund sites, approximately 20 of them have had some portion or step-wise stages of the thermal treatment remediation completed at this time. Apparently only 5 of the 93 have been completely remediated to date.

Depending on specific circumstances of the site and in addition to the Superfund legislation, other laws can govern remediation actions insofar as permitting, performance standards, waste shipping and handling, sampling and analytical procedures, quality assurance/quality control, and other activities. These include:

The Resource Conservation and Recovery Act of 1976 (RCRA), PL 94-580, October 21, 1976

The Hazardous and Solid Waste Amendments of 1984 (HSWA), PL 98-616, November 8, 1984

The Clean Air Act of 1963, PL 88-206 and the Amendment of August, 1977 or 42 USC 1857

The Alternative Motor Fuels Act of 1988, PL 100-494, October 14, 1988

The Toxic Substances Control Act (TSCA) PL 94-469, October 11, 1976 (15 USC 260) and the Amendment PL 100-551 of October 28, 1988

The Solid Waste Disposal Act, 42 USC 6901-6991i Consisting of PL 89-272 and the Amendments Made by Subsequent Enactments

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), 7 USC 136, and the 1988 Amendments, PL 100-532 October 25, 1988

The Medical Waste Tracking Act of 1988, PL 100-582, November 1, 1988

DISCUSSION

The process of high-temperature incineration has been used in the United States since the 1940's for a variety of industrial organic hazardous wastes, including liquids, contaminated solids, sludges, and bulk solid materials. The wastes are normally incinerated on the site of generation and/or by the off-site commercial waste disposal industry.

In the past ten to fifteen years, the EPA and industry have adapted the incineration techniques which have served well at stationary incinerators to mobile/transportable systems. These systems can be taken to field sites where organic chemicals have caused uncontrolled pollution of soils, air, and groundwater. Alternatively, samples of a field site's contaminated soil, debris, and liquids have been transported to stationary incinerators for disposal. Either scenario of incinerator-to-waste-site or waste-site-to- incinerator have been successfully demonstrated for contaminated soils.

After incineration, residues including ash and process water need to be evaluated. In some cases, the post-incinerated soil may be suitable for returning to the site. It should be recognized, however, that incineration will generally have removed all of the organics, leaving the soil void of nutrients necessary to support plant growth.

There are a number of steps which should be followed to assess whether a specific site is a suitable candidate for incineration. Some examples of these are the following:

- Develop a waste sampling and analysis survey to determine the nature, extent, and concentration of contaminants;

- Consider bench- or pilot-scale tests to demonstrate the effectiveness of incineration with the specific wastes;

- Determine the type and extent of any pre-processing requirements that may be indicated (shredding, special materials handling, solidifying liquids or sludges, neutralizing acid or caustic situations, etc.);

- Develop a management plan for rainfall and surface waters during remediation of the site;

- Determine the need for any special procedures for the control of dust, odors, or volatile releases during excavation;

- Develop site-specific incineration costs and schedules;

- Identify any RCRA, TSCA, or Superfund permitting procedures;
  Note: Superfund does not require permits but does require substantive compliance demonstration with RCRA, TSCA, etc.

- Develop well thought-out bidding procedures.

DEFINITIONS

The following definitions are those which have been popularly used by various EPA researchers as well as by many Superfund and industrial representatives.

Portable (or mobile) incinerators such as the one EPA itself has developed are truck or tractor/trailer mounted. The trailers plus the incineration equipment have to meet legal over-the-road specifications of trailer length, width, height, and weight. Most of the units require several trailers to accommodate the various components. However, the common characteristics are that the incineration system can be relatively quickly connected from trailer to trailer upon arrival at the site. Temporary concrete pads or bases to stabilize the trailers and temporary buildings and fences are generally erected. Portable incinerators require a minimum of field construction or erection to set up. Typically, portable incinerators may have a heat release capacity in the range of 3 to 15 million BTU/hour and a solids capacity of up to 2 or 3 tons per hour.

Transportable incinerators, on the other hand, are generally much larger units, too large in size or weight for their major assembled components to be mounted or moved intact on tractor trailers. The sub-assemblies or parts are transported to the site via truck or rail, but must be field erected and assembled on substantial concrete foundations on site much like a stationary incinerator. Provisions are made for ease of assembly and disassembly. Typically, their heat release capacities range in the 30 to 120 million BTU/hour size and their solids capacity may be in the 5 to 20 tons per hour range or more. Refractories must generally be field-installed, much like large stationary units. Transportable incinerators, once set up on site, resemble stationary units in their use of structural iron framework and substantial but temporary buildings.

DIAGNOSTIC TEST BURNS

As mentioned above, it may be required to demonstrate the "incinerability" of a given site's wastes by first conducting a burn or burns of some of the actual liquids, sludges, debris, and contaminated soils, before any decision to proceed with incineration. If the site's waste is very predictable and well-defined, it may be possible to simply wait until a mobile/transportable incinerator is moved and set up on site to obtain these data.

However, in many cases advance performance data are required for reasons of an unusual waste, particularly hazardous components (e.g., dioxins), a difficult to handle matrix, or as supporting information pursuant to decisions, regulatory permit actions, or public concerns, etc.

Test burn data in advance of the arrival of an actual incinerator on site can be pursued from such facilities as:

- EPA's stationary Incineration Research Facility in Jefferson, Arkansas. This facility has a pilot-scale rotary kiln with afterburner unit (3 million BTU/hr.) plus a pilot-scale liquid injection incinerator. Permits available generally cover all RCRA (including dioxins). Access is typically arranged through regional or headquarters EPA offices.

- Alternatively, prospective portable/transportable incinerator firms may have available pilot- or field-scale units of their technologies for test burn purposes.

These test burns are generally conducted on samples of the wastes taken from the actual site that are shipped to the incinerator unit.

EXAMPLES OF TECHNOLOGY AVAILABLE

Tables 1 through 10 show a number of example technologies of the portable or transportable types that are a major focus of this paper. During the verbal presentation, selected slide pictures of the actual hardware will be presented as well.

OVERVIEW OF THERMAL REMEDIATION ACTIONS

Table 11 shows a summary in terms of numbers of projects, the tonnages of contaminated soil, and the number of contractors and thermal units relative to all of the currently known thermal remediation projects that have either been finished, are on-going, or have been contracted for in the U.S. as of August 1990. The numbers of sites shown, it should be noted, include not only Superfund-type sites where thermal remediation was selected but also other types such as State-identified sites and some of the underground storage tank (UST) clean-up cases.

THERMAL/INCINERATION REMEDIATION CONTRACTORS, SITE DATA, AND PERFORMANCE OF EQUIPMENT

Table 12 shows the array of generic types of technology for thermal remediation listed by the name of the contractor offering the technology types. The number of units owned by each contractor is also shown. Basically, the table is a matrix of six (6) generic types of technology versus twenty (20) contractors.

Table 13 shows the same contractors in the previous table, but lists their names in terms of the relative size of site(s) in tons that their equipment has been applied to or is capable of treating.

Table 14 is a listing of some 64 sites involved in thermal remediation. Listed are the vendors or contractors for the clean-up equipment, site name and location, source of contamination, site size, and project status.

Table 15 is a table of equipment data for the various contractors along with the names of sites, numbers of units, the generic type of hardware, capacity, and type of air pollution control equipment used.

Finally, Table 16 lists, along with site name and vendor information, some specific performance data such as the contaminant concentrations and particulate emission performance and whether or not RCRA or TSCA permits were required and obtained.

Table 1. EPA's Mobile Incineration System Which Inspired the Development and Growth of Similar Portable/Transportable Field Site Incineration Systems in the Commercial Sector

Overall Characteristics:

- Developed by ORD during approximately 1970-1982

- Initial performance tests at EPA-Edison, New Jersey on PCBs and RCRA wastes

- Set up in Region VII in December, 1984 for Denney Farm dioxin-contaminated soils, debris, and liquids

- Accomplishments to date:

  12,500,000 pounds of solids treated
  230,000 pounds of liquids destroyed
  average throughput: 3,000 pounds per hr
  70 percent on-line time

- System description:

  nominal 12 million btu/hr total
  rotary kiln 52 in. ID x 16 ft. long
  afterburner 52 in. ID x 36 ft. long
  hot cyclone particle separator
  wet electrostatic precipitator
  fuel oil fired with air or oxygen
  shredder for waste preparation

- Current Status:

  Removed from Denney Farm Site

Table 2. Ogden Services Circulating Fluidized Bed Combustor (CBC)

- Four (4) mobile/transportable units
- Units are 10 MM BTU/hr and 4 to 5 tons/hr soil capacity
- Acid neutralization by dry lime injection into bed
- Fabric filter (bag house) for air pollution control
- CBC achieved 6-9s DRE on PCBs at 1600F
- Compounds treated: PCBs and petroleum hydrocarbons

Table 3. Canonie Low Temperature Thermal Aeration (LTTA) System

- One (1) unit; cleans soil to below 0.02 ppm contaminant
- Treatment of volatile organic compounds (VOCs) on soils
- Rotary dryer, heats soil to 300F, VOCs go into air stream, cleaned soil discharged and water quenched
- Cyclones and fabric filters for dust control
- Wet scrubber for acid gas control
- Activated carbon for VOC control, regenerated at 1200F off-site
- Capacity 15-20 cubic yards of soil per hour

Table 4. ENSCO Corporation Mobile or Transportable Incinerators

- Six (6) mobile units
- Smaller units are 5-6 tons/hr (4 units exist)
  50 MM btu/hr
- One larger unit is transportable, 15-20 tons/hr
  90 MM btu/hr
- Compounds treated:

  PCBs, dioxins, herbicide orange, other
  RCRA chemicals in contaminated soils

- Smaller ones have TSCA permits
- Cost of operation:

  at the Gulfport site, costs averaged $500
  per ton including all set-up, treatment, and
  tear-down

Table 5. Weston Services, Incorporated Transportable Incinerator

- One (1) unit
- Rotary kiln 7 ft. diameter x 25 ft. long
- Afterburner 8 ft. diameter x 33 ft. height
- Fabric filter air pollution control system
- Packed tower HCL control unit
- Design capacity 35 MM btu/hr and 5 to 6 tons/hour on
  contaminated soil & debris
- Compounds treated: PCBs (up to 1% or 10,000 ppm
  in soil)
- Unit has TSCA permit

Table 6. International Technology (IT) Transportable Incinerator

- Three (3) units exist

- Rotary kiln is 6-1/2 ft. diameter x 45 ft. long, countercurrent

- Afterburner is vertical, and designed for 2 seconds at 2190F

- Total heat capacity is 56 MM btu/hr

- Soil throughput capacity nominally 20 tons per hour, over 15 demonstrated

- Compounds treated: trinitrotoluene, di- and tri-nitrobenzene, PCBs, and styrene tar

Table 7. Vesta Technology Ltd. Mobile Incinerators

- Three (3) units exist: "Vesta 80" and two "Vesta 100s"

- Model 80 is an 8-MM btu 1 hr unit with a 5.03 Ft. diameter by 16 ft. long kiln and a 5.03 Ft. diameter by 20 ft. long afterburner

- Model 100 is a 12-MM btu/hr unit with a 4.33 ft. diameter by 25 ft. long kiln and a 5.33 ft. diameter by 30 ft. long afterburner

- Capacities claimed:

  Model 80: 1000-2000 pounds per hour of soils
  Model 100: 3000-5000 pounds per hour of soils

- Compounds treated: pesticides, DDT, pentachlorophenol, nitrobenzene, and dioxin

Table 8. Rollins Environmental Company's Rotary Reactor Transportable System (Formerly "Pedco/PEI Fast Rotary Reactor")

- 33.5 million btu/hr rotary kiln w/fluidized sand, recirculating
- Kiln is 10.9 ft. diameter x 65 ft. long
- Forecast capacity: 150 tons/day of 2500-3500 btu/lb. materials (claimed self-sustained combustion at that btu)
- Field-transportable version to have dry scrubbing (no water use)
- Current unit under test in Deer Park, Texas
- Smaller, pilot unit tested 1986 in stationary mode, used a 2 ft. 4 in. ID x 18 ft. long kiln/reactor
- Developed by PEI of Cincinnati, Ohio - Coal Office, and University of Cincinnati
- Target business:

  Initial: large sample test burns at Deer Park on Superfund soils, etc.

  Later: transport to field Superfund sites
- Status:

  Installed in Winter, 1988

  Stationary tests completed on solid/liquid RCRA & PCB wastes in early 1989 (dioxin permit pending)

  Currently in use

  Potential to convert to field-transportable unit using dry-scrubber in future

Table 9. Chemical Waste Management Transportable Incinerator

- Large rotary kiln plus afterburner, rated at 82 MM btu/hr
- Soils throughput capacity 15 to 20 tons/hr
- Uses bag house (fabric filter) plus wet scrubber
- Compounds treated: creosote, carbon tetrachloride, naphthalene, various solvents

Table 10. O.H. Materials Corporation Infrared Electric Furnace Technology

- One (1) mobile unit
- Infrared Section: 1600F, using a metal conveyor belt
- Afterburner section: 2000F
- Combustion gas cleaning: wet scrubber
- Processing capacity: up to 165 tons of soil per day
- Compounds treated: PCBs

TABLE 11. THERMAL REMEDIATION INDUSTRY PROJECT SUMMARY[a]

	PROJECT STATUS			
DESCRIPTION	FINISHED	ON-GOING	CONTRACTED	TOTAL
NO. OF PROJECTS	38	11	13	62
WASTE QUANTITY (TONS)	406,000	399,000	773,000	1,578,000
AVERAGE SITE SIZE (TONS)[b]	10,400	39,900	64,400	25,000
NO. OF CONTRACTORS				21
NO. OF THERMAL UNITS				43

[a]Projects through August 1990.
[b]Average includes only projects for which site size information is available.

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TABLE 12. TECHNOLOGY BY CONTRACTOR

CONTRACTOR	TECHNOLOGY AND NUMBER OF UNITS					
	ROTARY KILN	INFRARED CONVEYOR	CIRCULATING BED	LOW TEMP DIRECT DESORBER	LOW TEMP INDIRECT DESORBER	HIGH TEMP INDIRECT DESORBER
AET	3					
CANONIE				1		
CHEM WASTE	1					1
ENVIROTECH				3		
ENSCO	6					
GDC	1	1				
IT CORPORATION	3					
KIMMINS	1					
OGDEN			4			
OH MATERIALS		1		2		
SITE RECL. SYSTEMS				1		
SOIL REMEDIATION				1		
SOILTECH						1
TDI SERVICES						1
THERMODYNAMICS	1					
U.S. WASTE PROC.		1				
VERTAC SITE CON.	1					
VESTA	3					
WESTINGHOUSE		1				
WESTON	1				1	
WILLIAMS	1			1		
TOTALS	22	4	4	9	1	3

TABLE 13. SITE SIZE BY CONTRACTOR

CONTRACTOR	SITE SIZE (TONS) 0–1,000	1,000–5,000	5,000–20,000	20,000–50,000	>50,000
AET		X	X		X
CANONIE			X		
CHEM WASTE				X	
ENSCO			X	X	X
ENVIROTECH			X		
GDC		X			X
IT CORPORATION				X	X
KIMMINS					X
OGDEN			X	X	X
OH MATERIALS		X	X		
SITE RECL. SERVICES	X	X	X		
SOIL REMEDIATION	X	X			
SOILTECH			X	X	
TDI SERVICES				X	
THERMODYNAMICS		X			
U.S. WASTE PROC.	X	X	X		
VERTAC SITE CON.			X		
VESTA	X	X			
WESTINGHOUSE			X	X	
WESTON	X	X	X	X	
WILLIAMS	X	X	X	X	

TABLE 14. SITE DATA

VENDOR	SITE NAME	SITE LOCATION	ST	SOURCE OF CONTAMINATION	PROJECT STATUS	SITE SIZE (TONS)
AET	MULTIPLE SITES		LA	DRILLING FLUIDS	FINISHED	
AET	CONFIDENTIAL	VIRNAL	UT	OIL PRODUCTION PITS	CONTRACTED	112,000
CANONIE	OTTATI & GOSS	KINGSTON	NH	SOLVENT TREATMENT	FINISHED	8,000
CANONIE	CANON BRIDGEWATER	BRIDGEWATER	MA	SOLVENT RECYCLING	FINISHED	6,500
CANONIE	SOUTH KEARNY	SOUTH KEARNY	NJ	SOLVENT RECYCLING	FINISHED	18,000
CANONIE	MCKIN	GRAY	ME	WASTE TREATMENT AND DISPOSAL	FINISHED	18,000
CHEMICAL WASTE MGT.	RESOLVE	N. DARTMOUTH	MA	CHEMICAL RECLAMATION SITE	CONTRACTED	35,000
ENSCO	UNION CARBIDE	SEADRIFT	TX	RCRA WASTES AND LAGOON SLUDGES	CONTRACTED	100,000
ENSCO	LENZ OIL	LEMONT	IL	WASTE OIL	FINISHED	26,000
ENSCO	SYDNEY MINES	BRANDON	FL	WASTE OIL LAGOON	FINISHED	10,000
ENSCO	NCBC	GULFPORT	MS	HERBICIDE STORAGE	FINISHED	22,000
ENSCO	BRIDGEPORT RENTAL	BRIDGEPORT	NJ	USED OIL RECYCLING	ONGOING	100,000
ENSCO	SMITHVILLE	SMITHVILLE	CANADA	PCB TRANSFORMER LEAKS	CONTRACTED	7,000
ENVIROTECH	S&S FLYING	MARIANNA	FL	PESTICIDE SPRAY FORMULATION	FINISHED	5,200
GDC ENGINEERING	RUBICON	GEISMAR	LA	CHEMICAL MANUFACTURING	ONGOING	52,000
GDC ENGINEERING	HOESCHT CEL.	SHELBY	NC	LANDFILL TRENCHES	CONTRACTED	3,000
IT CORPORATION	MOTCO	LAMARQUE	TX	STYRENE TAR DISPOSAL PITS	ONGOING	80,000
IT CORPORATION	CORNHUSKER AAP	GRAND ISLAND	NE	MUNITONS PLANT REDWATER PITS	FINISHED	45,000
IT CORPORATION	LOUISIANA AAP	MINDEN	LA	MUNITONS PLANT REDWATER LAGOON	FINISHED	100,000
IT CORPORATION	SIKES PITS	CROSBY	TX	CHEMICAL WASTE DISPOSAL PITS	CONTRACTED	341,000
KIMMINS	LASALLE	LASALLE	IL	PCB CAPACITOR MANUFACTURING	CONTRACTED	69,000
OGDEN	CONFIDENTIAL	SACRAMENTO	CA	TOWN GAS SITE	CONTRACTED	22,500
OGDEN	SWANSON RIVER	KENAI	AK	OIL PIPELINE COMPRESSOR OIL	ONGOING	80,000
OGDEN	STOCKTON	STOCKTON	CA	UNDERGROUND TANK OIL LEAK	FINISHED	16,000
OH MATERIALS	GOOSE BAY	GOOSE BAY	CANADA	PCB TRANSFORMER OILS	FINISHED	4,000
OH MATERIALS	GAS STATION	COCOA	FL	PETROLEUM TANK LEAK	FINISHED	1,000
OH MATERIALS	RAIL YARD	CONFIDENTIAL	PA	REPETITIVE SPILLS	FINISHED	1,500
OH MATERIALS	TWIN CITY AAP	NEW BRIGHTON	MN	MUNITIONS PLANT	FINISHED	2,000
OH MATERIALS	RAIL YARD	CONFIDENTIAL	PA	DIESEL TANK SPILL	FINISHED	1,300
OH MATERIALS	FLORIDA STEEL	INDIANTOWN	FL	STEEL MILL USED OILS	FINISHED	18,000
OH MATERIALS	RAIL YARD	CLEVELAND	OH	REFUELING STATION	FINISHED	1,500

TABLE 14. SITE DATA (CONTINUED)

VENDOR	SITE NAME	SITE LOCATION	ST	SOURCE OF CONTAMINATION	PROJECT STATUS	SITE SIZE (TONS)
OH MATERIALS	CONFIDENTIAL	CONFIDENTIAL	KY	TIN SLUDGE LAGOON	ONGOING	7,500
SITE RECL. SYSTEMS	KOCH CHEMICAL	PITTSBURGH	KS	TANK BOTTOMS	FINISHED	1,100
SITE RECL. SYSTEMS	MULTIPLE SITES	FAIRBANKS	AK	OIL SPILLS AND UST	ONGOING	7,000
SITE RECL. SYSTEMS	SUN OIL	MULTIPLE SITES	NY	OIL SPILLS AND UST	CONTRACTED	
SITE RECL. SYSTEMS	WEYERHAEUSER	RAYMOND	WA	UST GAS AND DIESEL	CONTRACTED	5,000
SOIL REMEDIATION CO.	MULTIPLE SITES	MULTIPLE SITES	SC	GAS AND OIL LEAKS/SPILLS	FINISHED	3,000
SOILTECH	WIDE BEACH	BRANT	NY	PCB CONTAMINATED ROAD OIL	ONGOING	25,000
SOILTECH	WAUKEGAN HARBOR	WAUKEGAN	IL	MARINE MOTOR MANUFACTURING	CONTRACTED	20,000
TDI SERVICES	CHEVRON REFINERY	EL SEGUNDO	CA	API AND LAGOON SLUDGES	ONGOING	30,000
THERMODYNAMICS CORP	S. CROP SERVICES	DELRAY BEACH	FL	CROP DUSTING OPERATION	FINISHED	1,800
U.S. WASTE THERMAL PROC.	GAS STATION	TEMECULA	CA	PETROLEUM TANK LEAK	FINISHED	1,000
U.S. WASTE THERMAL PROC.	CALTRANS	YUCIPA	CA	OIL SPILLS	FINISHED	1,300
U.S. WASTE THERMAL PROC.	CONFIDENTIAL	SAN BERNADINO	CA	UST LEAKS	FINISHED	5,400
U.S. WASTE THERMAL PROC.	CITY OF SAN BERN.	SAN BERNADINO	CA	UST LEAKS	FINISHED	1,900
U.S. WASTE THERMAL PROC.	RIVERSIDE WATER	TEMECULA	CA	UST LEAKS	FINISHED	1,800
VERTAC SITE CONTRACTORS	VERTAC	JACKSONVILLE	AR	CHEMICAL MANUFACTURING	CONTRACTED	6,500
VESTA	NYANZA	ASHLAND	MA	DYE MANUFACTURING	FINISHED	1,000
VESTA	ROCKY BOY	HAVRE	MT	WOOD TREATMENT	FINISHED	1,800
VESTA	S. CROP SERVICES	DELRAY BEACH	FL	CROP DUSTING OPERATION	FINISHED	1,800
VESTA	AMERICAN CROSSARM	CHEHALIS	WA	WOOD TREATMENT	FINISHED	900
VESTA	FORT A.P. HILL	BOWLING GREEN	VA	ARMY BASE	FINISHED	200
VESTA	BLACK FEET POLE	BROWNING	MT	WOOD TREATMENT	ONGOING	1,200
WESTINGHOUSE/HAZTECH	PEAK OIL	TAMPA	FL	USED OIL RECYCLING	FINISHED	7,000
WESTINGHOUSE/HAZTECH	LASALLE	LASALLE	IL	TRANSFORMER RECONDITIONING	FINISHED	30,000
WESTON	REVENUE	SPRINGFIELD	IL	GAS AND FUEL OIL UST	FINISHED	1,000
WESTON	TINKER AFB	OKLAHOMA CITY	OK	AIR FORCE BASE	FINISHED	1,000
WESTON	CROW'S LANDING	MODESTO	CA	FIRE TRAINING PIT	CONTRACTED	1,700
WESTON	PAXTON AVENUE	CHICAGO	IL	WASTE LAGOON	ONGOING	16,000
WESTON	LAUDER SALVAGE	BEARDSTOWN	IL	METAL SCRAP SALVAGE	FINISHED	8,500
WESTON	SAVANNA AAP	SAVANNA	IL	RED/PINK WATER LAGOONS	CONTRACTED	25,000

TABLE 14. SITE DATA (CONTINUED)

VENDOR	SITE NAME	SITE LOCATION	ST	SOURCE OF CONTAMINATION	PROJECT STATUS	SITE SIZE (TONS)
WESTON	ALABAMA AAP	CHILDERSBURG	AL	MULTIPLE PLANT LOCATIONS	CONTRACTED	25,000
WILLIAMS INCIN. SERVS.	BOG CREEK	HOWELL TWP.	NJ	PAINT/SOLVENT DISPOSAL	FINISHED	22,500
WILLIAMS INCIN. SERVS.	MULTIPLE SITES	SOUTHEAST		UST LEAKS	ONGOING	
WILLIAMS INCIN. SERVS.	PRENTISS CREOSOTE	PRENTISS	MS	WOOD TREATMENT	FINISHED	9,200

TABLE 15. EQUIPMENT DATA

VENDOR	SITE NAME	NO. OF UNITS	COMBUSTION EQUIPMENT TYPE	THERMAL CAPACITY (MM BTU/HR)	APC EQUIPMENT TYPE
AET	MULTIPLE SITES	1	ROTARY KILN	14	CYCLONE, QUENCH, PACKED BED
AET	CONFIDENTIAL	1	ROTARY KILN	21	CYCLONE, QUENCH, PACKED BED
CANONIE	OTTATI & GOSS	1	ASPHALT KILN	55	BAGHOUSE, CARBON, SCRUBBER
CANONIE	CANON BRIDGEWATER	1	ASPHALT KILN	55	BAGHOUSE, CARBON, SCRUBBER
CANONIE	SOUTH KEARNY	1	ASPHALT KILN	55	BAGHOUSE, CARBON, SCRUBBER
CANONIE	MCKIN	1	ASPHALT KILN	55	BAGHOUSE, CARBON, SCRUBBER
CHEMICAL WASTE MGT.	RESOLVE	1	HIGH TEMPERATURE INDIRECT DESORBER	21	CONDENSATION, CARBON
ENSCO	UNION CARBIDE	1	ROTARY KILN	50	STEAM EJECTOR SCR.
ENSCO	LENZ OIL	1	ROTARY KILN	50	STEAM EJECTOR SCR.
ENSCO	SYDNEY MINES	1	ROTARY KILN	50	STEAM EJECTOR SCR.
ENSCO	NCBC	1	ROTARY KILN	50	STEAM EJECTOR SCR.
ENSCO	BRIDGEPORT RENTAL	1	ROTARY KILN	90	STEAM EJECTOR SCR.
ENSCO	SMITHVILLE	1	ROTARY KILN	50	STEAM EJECTOR SCR.
ENVIROTECH	S&S FLYING	1	LOW TEMPERATURE DIRECT DESORBER	72	CYCLONE, VENTURI
GDC ENGINEERING	RUBICON	1	INFRARED CONVEYOR FURNACE	30	WATERLOO SCRUBBER
GDC ENGINEERING	HOESCHT CEL.	1	ROTARY KILN	20	BAGHOUSE, WET SCRUBBER
IT CORPORATION	MOTCO	2	ROTARY KILN	56	HYDROSONICS TANDEM SCRUBBER
IT CORPORATION	CORNHUSKER AAP	1	ROTARY KILN	56	HYDROSONICS TANDEM SCRUBBER
IT CORPORATION	LOUISIANA AAP	1	ROTARY KILN	56	HYDROSONICS TANDEM SCRUBBER
IT CORPORATION	SIKES PITS	1	ROTARY KILN	120	HYDROSONICS TANDEM SCRUBBER
KIMMINS	LASALLE	1	ROTARY KILN	100	BAGHOUSE, PACKED BED
OGDEN	CONFIDENTIAL	1	CIRCULATING FLUID BED	10	BAGHOUSE
OGDEN	SWANSON RIVER	1	CIRCULATING FLUID BED	10	BAGHOUSE
OGDEN	STOCKTON	1	CIRCULATING FLUID BED	10	BAGHOUSE
OH MATERIALS	GOOSE BAY	1	INFRARED CONVEYOR FURNACE	30	VENTURI, PACKED BED
OH MATERIALS	GAS STATION	1	LOW TEMPERATURE DIRECT DESORBER	12	VENTURI
OH MATERIALS	RAIL YARD	1	LOW TEMPERATURE DIRECT DESORBER	20	CYCLONE, VENTURI
OH MATERIALS	TWIN CITY AAP	1	INFRARED CONVEYOR FURNACE	30	VENTURI, PACKED BED
OH MATERIALS	RAIL YARD	1	LOW TEMPERATURE DIRECT DESORBER	20	CYCLONE, VENTURI
OH MATERIALS	FLORIDA STEEL	1	INFRARED CONVEYOR FURNACE	30	VENTURI, PACKED BED
OH MATERIALS	RAIL YARD	1	LOW TEMPERATURE DIRECT DESORBER	20	CYCLONE, VENTURI

TABLE 15. EQUIPMENT DATA (CONTINUED)

VENDOR	SITE NAME	NO. OF UNITS	COMBUSTION EQUIPMENT TYPE	THERMAL CAPACITY (MM BTU/HR)	APC EQUIPMENT TYPE
OH MATERIALS	CONFIDENTIAL	1	LOW TEMPERATURE DIRECT DESORBER	20	CYCLONE, VENTURI
SITE RECL. SYSTEMS	KOCH CHEMICAL	1	ASPHALT KILN	47	BAGHOUSE
SITE RECL. SYSTEMS	MULTIPLE SITES	1	ASPHALT KILN	47	BAGHOUSE
SITE RECL. SYSTEMS	SUN OIL	1	ASPHALT KILN	47	BAGHOUSE
SITE RECL. SYSTEMS	WEYERHAEUSER	1	ASPHALT KILN	47	BAGHOUSE
SOIL REMEDIATION CO.	MULTIPLE SITES	1	ASPHALT KILN	48	CYCLONE, BAGHOUSE
SOILTECH	WIDE BEACH	1	HIGH TEMPERATURE INDIRECT DESORBER	14	BAGHOUSE, CYCLONE, SCRUBBER
SOILTECH	WAUKEGAN HARBOR	1	HIGH TEMPERATURE INDIRECT DESORBER	14	BAGHOUSE, CYCLONE, SCRUBBER
TDI SERVICES	CHEVRON REFINERY	1	HIGH TEMPERATURE INDIRECT DESORBER		CONDENSATION, CARBON
THERMODYNAMICS CORP	S. CROP SERVICES	1	ROTARY KILN	7	WET SCRUBBER
U.S. WASTE THERMAL PROC.	GAS STATION	1	INFRARED CONVEYOR FURNACE	10	CALVERT SCRUBBER
U.S. WASTE THERMAL PROC.	CALTRANS	1	INFRARED CONVEYOR FURNACE	10	CALVERT SCRUBBER
U.S. WASTE THERMAL PROC.	CONFIDENTIAL	1	INFRARED CONVEYOR FURNACE	10	CALVERT SCRUBBER
U.S. WASTE THERMAL PROC.	CITY OF SAN BERN.	1	INFRARED CONVEYOR FURNACE	10	CALVERT SCRUBBER
U.S. WASTE THERMAL PROC.	RIVERSIDE WATER	1	INFRARED CONVEYOR FURNACE	10	CALVERT SCRUBBER
VERTAC SITE CONTRACTORS	VERTAC	1	ROTARY KILN	35	SPRAY DRYER, BAGHOUSE, SCRUBBER
VESTA	NYANZA	1	ROTARY KILN	8	WET SCRUBBER
VESTA	ROCKY BOY	1	ROTARY KILN	12	WET SCRUBBER
VESTA	S. CROP SERVICES	1	ROTARY KILN	12	WET SCRUBBER
VESTA	AMERICAN CROSSARM	1	ROTARY KILN	12	WET SCRUBBER
VESTA	FORT A.P. HILL	1	ROTARY KILN	12	WET SCRUBBER
VESTA	BLACK FEET POLE	1	ROTARY KILN	12	WET SCRUBBER
WESTINGHOUSE/HAZTECH	PEAK OIL	1	INFRARED CONVEYOR FURNACE	30	WET SCRUBBER
WESTINGHOUSE/HAZTECH	LASALLE	1	INFRARED CONVEYOR FURNACE	30	WET SCRUBBER
WESTON	REVENUE	1	LOW TEMPERATURE INDIRECT DESORBER	12	BAGHOUSE
WESTON	TINKER AFB	1	LOW TEMPERATURE INDIRECT DESORBER	12	BAGHOUSE, WET SCRUBBER
WESTON	CROW'S LANDING	1	LOW TEMPERATURE INDIRECT DESORBER	12	BAGHOUSE, CONDENSER, CARBON
WESTON	PAXTON AVENUE	1	ROTARY KILN	35	BAGHOUSE, PACKED BED
WESTON	LAUDER SALVAGE	1	ROTARY KILN	35	BAGHOUSE, PACKED BED
WESTON	SAVANNA AAP	1	ROTARY KILN	35	BAGHOUSE, PACKED BED

TABLE 15. EQUIPMENT DATA (CONTINUED)

VENDOR	SITE NAME	NO. OF UNITS	COMBUSTION EQUIPMENT TYPE	THERMAL CAPACITY (MM BTU/HR)	APC EQUIPMENT TYPE
WESTON	ALABAMA AAP	1	ROTARY KILN	35	BAGHOUSE, PACKED BED
WILLIAMS INCIN. SERVS.	BOG CREEK	1	ROTARY KILN	82	CYCLONE, BAGHOUSE, PACKED BED
WILLIAMS INCIN. SERVS.	MULTIPLE SITES*	1	LOW TEMPERATURE DIRECT DESORBER	21	BAGHOUSE
WILLIAMS INCIN. SERVS.	PRENTISS CREOSOTE	1	ROTARY KILN	82	CYCLONE, BAGHOUSE, PACKED BED

TABLE 16. PERFORMANCE DATA

VENDOR	SITE NAME	INDICATOR COMPOUND	CONTAMINANT CONCENTRATION IN TREATED SOIL (mg/kg)	TRIAL BURN REQUIRED	PARTICULATE EMISSIONS (GR/DSCF @7% O2)	RCRA PERMIT	TSCA PERMIT
AET	MULTIPLE SITES	TPH, BTEX		NO		NO	NO
AET	CONFIDENTIAL	TPH, BTEX		YES	0.08	NO	NO
CANONIE	OTTATI & GOSS	VOLATILE ORGANICS	< 0.2	YES	0.03	NO	NO
CANONIE	CANON BRIDGEWATER	TOTAL VOC	< 0.1	NO		NO	NO
CANONIE	SOUTH KEARNY	VOLATILE ORGANICS		NO		NO	NO
CANONIE	MCKIN	TRICHLOROETHYLENE	< 0.1	YES	0.03	NO	NO
CHEMICAL WASTE MGT.	RESOLVE	PCBs	< 25	NO		NO	NO
ENSCO	UNION CARBIDE	VARIOUS RCRA CONSTITUENT	LDR	YES	0.03	YES	NO
ENSCO	LENZ OIL	HYDROCARBONS	< 5.0	YES	0.006	NO	NO
ENSCO	SYDNEY MINES	HYDROCARBONS	< 5.0	NO	0.08	NO	NO
ENSCO	NCBC	DIOXIN	< 15PPT	YES	0.017	NO	NO
ENSCO	BRIDGEPORT RENTAL	PCBs	< 2.0	YES	0.03	NO	YES
ENSCO	SMITHVILLE	PCBs	< 0.5	YES	0.03	NO	YES
ENVIROTECH	S&S FLYING	TOXAPHENE	<0.1	YES	0.01	NO	NO
GDC ENGINEERING	RUBICON	MCBz and DCBz	TCLP	YES		NO	NO
GDC ENGINEERING	HOESCHT CEL.	ETHYLENE GLYCOL		YES	0.08	NO	NO
IT CORPORATION	MOTCO	PCBs (TCLP EXTRACT)	0.028 mg/l	YES	0.08	NO	NO
IT CORPORATION	CORNHUSKER AAP	TRINITROTOLUENE (TNT)	< 1.3	YES	0.0017	NO	NO
IT CORPORATION	LOUISIANA AAP	TNT	< 1.3	YES	NR	NO	NO
IT CORPORATION	SIKES PITS	TOTAL PNAs	< 100	YES	0.08	NO	NO
KIMMINS	LASALLE	PCBs	< 2.0	YES	0.08	NO	NO
OGDEN	CONFIDENTIAL						
OGDEN	SWANSON RIVER	PCBs	< 0.1	YES	0.05	NO	YES
OGDEN	STOCKTON	TPH	< 1	YES	0.08	NO	NO
OH MATERIALS	GOOSE BAY	PCBs	<0.5	YES	0.031	NO	YES
OH MATERIALS	GAS STATION	BTEX	< 0.1	YES	0.011	NO	NO
OH MATERIALS	RAIL YARD	DIESEL OIL	< 100	NO		NO	NO
OH MATERIALS	TWIN CITY AAP	PCBs	< 2	NO	0.08	NO	YES
OH MATERIALS	RAIL YARD	DIESEL OIL	< 100	NO		NO	NO
OH MATERIALS	FLORIDA STEEL	PCBs	< 2	YES	0.056	NO	YES
OH MATERIALS	RAIL YARD	TPH	< 50	YES	0.039	NO	NO

TABLE 16. PERFORMANCE DATA (CONTINUED)

VENDOR	SITE NAME	INDICATOR COMPOUND	CONTAMINANT CONCENTRATION IN TREATED SOIL (mg/kg)	TRIAL BURN REQUIRED	PARTICULATE EMISSIONS (GR/DSCF @7% O2)	RCRA PERMIT	TSCA PERMIT
WESTON	ALABAMA AAP	9 EXPLOSIVES	< 1 (EACH)	YES	0.08	NO	NO
WILLIAMS INCIN. SERVS.	BOG CREEK	TOTAL ORGANICS	< 1	YES	0.015	NO	NO
WILLIAMS INCIN. SERVS.	MULTIPLE SITES	TPH	< 100	NO		NO	NO
WILLIAMS INCIN. SERVS.	PRENTISS CREOSOTE	POLYNUCLEAR AROMS (PNAs)	< 2	YES	0.011	NO	NO

LDR - LAND DISPOSAL RESTRICTION TREATMENT STANDARDS.

PARTICULATE IS A COMBINATION OF REGULATORY STANDARDS AND ACTUAL PERFORMANCE.

NR - NOT REQUIRED

TPH - TOTAL PETROLEUM HYDROCARBONS

BTEX - BENZENE, TOLUENE, ETHYLBENZENE, XYLENE

TABLE 16. PERFORMANCE DATA (CONTINUED)

VENDOR	SITE NAME	INDICATOR COMPOUND	CONTAMINANT CONCENTRATION IN TREATED SOIL (mg/kg)	TRIAL BURN REQUIRED	PARTICULATE EMISSIONS (GR/DSCF @7% O2)	RCRA PERMIT	TSCA PERMIT
OH MATERIALS	CONFIDENTIAL	TIN RECOVERY PROJECT		NO	NR	NO	NO
SITE RECL. SYSTEMS	KOCH CHEMICAL	TOLUENE, XYLENE		NO		NO	NO
SITE RECL. SYSTEMS	MULTIPLE SITES	TPH	<100	NO	0.05	NO	NO
SITE RECL. SYSTEMS	SUN OIL	TPH		YES		NO	NO
SITE RECL. SYSTEMS	WEYERHAEUSER	TPH	<100	NO	NR	NO	NO
SOIL REMEDIATION CO.	MULTIPLE SITES	TPH	< 50			NO	NO
SOILTECH	WIDE BEACH	PCBs	< 2	YES		NO	NO
SOILTECH	WAUKEGAN HARBOR	PCBs		YES		NO	NO
TDI SERVICES	CHEVRON REFINERY	SEE 40 CFR 268	LDR	NO	NR	NO	NO
THERMODYNAMICS CORP	S. CROP SERVICES	PENTACHLOROPHENOL	0.003	YES	0.035	NO	NO
U.S. WASTE THERMAL PROC.	GAS STATION	TPH	< 10	YES	0.008	NO	NO
U.S. WASTE THERMAL PROC.	CALTRANS	TPH	< 10	NO	NR	NO	NO
U.S. WASTE THERMAL PROC.	CONFIDENTIAL	TPH	< 10	NO	NR	NO	NO
U.S. WASTE THERMAL PROC.	CITY OF SAN BERN.	TPH	< 10	NO	NR	NO	NO
U.S. WASTE THERMAL PROC.	RIVERSIDE WATER	TPH	< 10	NO	NR	NO	NO
VERTAC SITE CONTRACTORS	VERTAC	DIOXINS		YES	0.08	NO	NO
VESTA	NYANZA	NITROBENZENE		YES	0.02	NO	NO
VESTA	ROCKY BOY	DIOXIN, PCP	< 0.001,0.2	YES		NO	NO
VESTA	S. CROP SERVICES	DDT	< 0.2	YES	0.03	NO	NO
VESTA	AMERICAN CROSSARM	DIOXIN	< 0.001	YES	0.011	NO	NO
VESTA	FORT A.P. HILL	DIOXIN	< 0.001	YES	0.02	NO	NO
VESTA	BLACK FEET POLE	DIOXIN, PCP	< 0.001,0.2	YES	0.08	NO	NO
WESTINGHOUSE/HAZTECH	PEAK OIL	PCBs	< 1	YES	0.08	NO	NO
WESTINGHOUSE/HAZTECH	LASALLE	PCBs	< 2	YES	0.08	NO	NO
WESTON	REVENUE	PAHs	< 0.33	NO		NO	NO
WESTON	TINKER AFB	TRICHLOROETHYLENE		NO		NO	NO
WESTON	CROW'S LANDING						
WESTON	PAXTON AVENUE	PNAs	< 5	YES		NO	NO
WESTON	LAUDER SALVAGE	PCBs	< 2	YES	0.02	NO	YES
WESTON	SAVANNA AAP	9 EXPLOSIVES	< 1 (EACH)	YES	0.08	NO	NO

ASE STUDIES OF THERMAL AND NON-THERMAL CLEAN-UP METHODS

ase 1: Thermal

ne notable example of successful site remediation via incineration is a ite which was contaminated with explosives manufacturing wastes or "pink ater" known as the Louisiana Army Ammunition Plant (LAAP) (9). The IT orporation carried out the remediation utilizing IT's patented Hybrid hermal Treatment System (HTTS). Beginning in May 1988, approximately 02,000 tons of soil containing low levels of nitro-explosives were econtaminated by incineration. The replacement of the cleaned soil and ompletion of remediation at this site was accomplished in mid-1990. omina capacity of the HTTS used here is 22 tons per hour with a 56 illion BTU per hour unit consisting of a direct-fired rotary kiln with a 5-45 minute residence time, a secondary combustion chamber (afterburner) perating at up to 2200F, and an air pollution control system consisting f a ater quench chamber, gas conditioner, and a Hydro-Sonic scrubber nit. Cleaned combustion gases were discharged via a 60-foot tall stack.

ise 2: Thermal

nother example of incineration used for remediation is an ongoing roject using an Ogden Environmental Services Inc. (OES) circulating luidized bed combustor (CBC) incinerator at a PCB-contaminated site on e Kenai Peninsula in Alaska (10). The site is located approximately 0 miles from Anchorage, Alaska, on a U.S. Fish and Wildlife Service fuge. The site was a former oilfield, and PCB contamination resulted om the explosion of a compressor station in 1972. Over 80,000 tons of B-contaminated soils were treated here, and the treated soil has been own to contain less than 0.1 ppm PCB as compared to 50 ppm and higher vels initially. Incineration began in September 1989, and as of August 90. Ogden had processed over 44,000 tons of soil. The incinerator il s a 1600 to 1700F fluidized bed unit which meets the 99.9999 rcent destruction and removal efficiency (DRE) requirement for PCBs. e system utilizes limestone addition to the bed, combined with rticulate removal via a fabric filter pollution control unit.

se 3: Thermal

example of a completed project of incineration clean-up of PCB-ntaminated soil and sediments utilizing an mobile infrared conveyor lt-type incinerator by O. H. Materials Corporation (11) is the Florida eel site in Indiantown, Florida. Some 18,000 tons of soil were ntaminated with PCB hydraulic oils which leaked from several pieces of chanical equipment. The incinerator began operations in September 87, and clean-up was completed by May 1988. The 6 ton per hour unit erated with a 1200F ash exit temperature from the primary infrared amber and a 2200F secondary combustion chamber with 4 seconds of residence time. The pollution control system included a quench chamber, a venturi scrubber, a Chevron demister, and a packed tower scrubber. From initial contamination levels up to 7,000 ppm PCB, treated ash or soil was found to pass a 2 ppm allowable level.

Case 4: Thermal

The USEPA's mobile incinerator successfully cleaned up a site in Missouri known as the Denney Farm site during the 1985 through 1989 period as a research demonstration of the capabilities of mobile incineration. The site was contaminated with 2,3,7,8-tetrachlorodibenzo(p)dioxin and related compounds. Some 12,500,000 pounds of solids and 230,000 pounds of liquids were incinerated from this and seven other nearby southwestern Missouri dioxin sites. Most importantly, the incinerator ash (remediated soils) as well as the incinerator wastewaters were able to be delisted as non hazardous. In addition to dioxin, the incinerator also successfully destroyed PCBs, carbon tetrachloride, hexachloroethane, trichlorobenzene, and other organics (8).

Case 5: Chemical Treatment

As yet, there are no full-scale examples to report where site remediation by chemical treatment of contaminated soils has been used because the technologies are still undergoing development and scale up. However, a number of promising chemical systems to treat halogenated contaminants have been under study for several years.

One recent and successful pilot-scale test of EPA's "KPEG", or potassium polyethylene glycol, process was conducted at a U.S. Navy site on the island of Guam where a 1.5 to 2.0 cubic yard portable batch processing unit was tested on PCB-contaminated soils. Approximately 15 cubic yards of soil was treated in a rotary mixer-type unit. The treatment results showed reductions in PCB contamination from initial values of roughly 5 to 2000 ppm down to the 0.15 to 15.2 ppm range. Similar tests have also demonstrated successful treatment of dioxin-contaminated soils.

Additional progress is underway to explore the performance of newer chemical systems, to expand the scale and capacity of this type of equipment, and to evaluate the advantages of mild heating of the soil and reagent mixture (e.g., to 300F).

Case 6: Solidification

Currently, EPA records show that solidification has been selected for over 30 contaminated sites, typically sites with heavy metals as the primary contamination. The solidification treatment process can use portland cement or one of a few proprietary formulations. One site, for example, known as the Independent Nail site in EPA Region VI in South Carolina, has been solidified by adding 20 percent by weight of portland cement as the binding agent to the original 6,600 cubic yards of contaminated soil. The contamination consisted mainly of zinc, chromium, cadmium, and nickel. The mixing and treating was done by an on-site batch process and resulted in a negligible increase in volume. This site is currently undergoing a delisting process. Of the 30-plus other sites, only one other site is known to have been completed and passed the delisting process at this time.

SUMMARY AND CONCLUSIONS

Thermal treatment of soil in uncontrolled dumpsites which are contaminated with organics and inorganics is becoming increasingly popular. This paper has assembled summary data describing the number of different thermal technologies available and relevant information on the many sites at which this solution has been applied or is scheduled to be applied. Because of the rapidly growing and advancing nature of this industry, the authors recommended that the readers look for periodic updates and expansions of this type of information from the literature. Five examples of other literature sources are References 5, 6, 9, 10, and 11 listed below. However, the information contained herein represents the current status and technology state-of-the-art as best we can determine.

SLIDE PRESENTATION

During the oral presentation of this paper, a number of slides are planned to be shown including projections of key tables within this report as well as pictures showing views of the actual incinerator hardware in operation at specific sites.

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